

Endemic and rare Arthropod species in High Endemism Areas (HEA) of Algarve (South Portugal)

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Abstract

Here, we present the results of the study of several Arthropod groups collected by us in High Endemism Areas (HEA) of Algarve, the Southernmost province of Portugal. This study has revealed endemic species, species presenting a restricted distribution and species not yet recorded to our fauna: 15 species of *Collembola* endemic to Portugal or to the Iberian Peninsula, 13 species with a Mediterranean or Atlantic Mediterranean distribution, 20 species new to Portugal and 3 species new to the Iberian Peninsula (GAMA *et al.*, 1997); one species of *Isopoda* endemic to the Iberian Peninsula, 4 species with a Mediterranean or Atlantic-Mediterranean distribution, 2 species not yet referred to Portugal and 2 species new to the Iberian Peninsula; one Lusitanian species of *Pseudoscorpiones* and 7 species with a Mediterranean or Atlantic-Mediterranean distribution, from which 2 are cited for the first time to our country; among the 11 species of *Paupoda* identified, 10 are new to Portugal, one of them, described recently (SCHELLER, 1998), being a presumed endemic and 6 species with an European, Mediterranean or Atlantic-Mediterranean distribution; one Mediterranean species of *Diplura*; one Mediterranean species of *Embioptera*; 3 species of *Psocoptera* with an European, Mediterranean or Atlantic-Mediterranean distribution, from which 2 are new to Portugal and one cosmopolitan species also cited for the first time to our country; one species of *Thysanoptera* probably new to Portugal. From the database of D. DRUGMAND 37 endemic species and 5 endemic subspecies of *Staphylinidae* were referred to Algarve. The findings obtained in this study reinforce the idea that the High Endemism Areas in Algarve, supporting a great variety of endemic and rare Arthropod species, present a high biological value. The authors emphasise that for the preservation and the restoration of this biological richness, in addition to the creation of protective measures, it is absolutely necessary to recognize the essential role played by modern taxonomy in the identification and monitoring of the biological diversity components.

Keywords : Endemism, Biodiversity, Conservation.

Introduction

Biological diversity must be considered on three levels including the entire range of living species, the genetic variation among the individuals within a species and the ecosystems constituted by biological communities together with their associated environment (PRIMACK, 1998).

The interest of the scientific community and the general public in protecting biological diversity has intensified during the last decades in response to the crisis caused by an unprecedented period of species extinction. Biodiversity, the grand result of evolutionary processes and events tracing back several billion years, is itself rapidly declining (MEFFE & CARROLL, 1997).

Conservation biology is a new multidisciplinary concept that aims to investigate human impact on species, communities and ecosystems and to develop practical approaches to prevent the extinction of species, the loss of genetic variation and the destruction of biological communities.

This concept complements the applied disciplines of agriculture, forestry, etc. and provides a more general approach to the protection of biological diversity. It differs from these disciplines in placing the preservation of the entire biological community as its principal priority relative to economic factors. A clear difference between conservation biology and the traditional academic disciplines of taxonomy, ecology, genetics, etc. is that conservation biology addresses specific questions relating to the best strategies for protecting rare species, designing nature reserves, reconciling conservation concerns with human needs, etc. (PRIMACK, 1998).

Among the three main arguments for protecting soil biodiversity (Ecological, Utilitarian and Ethical arguments), the last, focusing on the intrinsic value of all life forms, is very important in conservation biology (HÄGVAR, 1998).

In this context it is indispensable to preserve and restore the habitats where species exist, with particular attention to rare and especially to endemic species, which represent the most valuable and vulnerable component of soil communities (DEHARVENG, 1996).

Algarve, the southernmost province of Portugal, presents a wide variety of soil diversity which allows us to distinguish five well defined ecological areas with several endemic species of flowering plants (ROCHA AFONSO, 1991) and arthropods (Thysanura (MENDES, 1985, 1992), Homoptera Cicadoidea Tibicnidae (BOULARD, 1982; QUARTAU, 1995) and Coleoptera Cicindelidae (HORN, 1937; SERRANO, 1988, 1995)) (Table 1).

The study of the Collembola populations from these areas of high endemism (HEA) has revealed 15 endemic or presumed endemic species to Algarve, to Portugal or to the Iberian Peninsula, 23 species recorded for the first time in Portugal or in the Iberian Peninsula and some species with a restricted distribution (GAMA *et al.*, 1997) (see also Table 2).

Table 1. Endemic or rare plants and arthropods from High Endemism Areas in Algarve already known before.

	Sagres	Serra de Monchique	Barrocal	Ria Formosa	Castro Marim
Phanerogams					
<i>Iberis sampaiana</i> FRANCO & P. SILVA, 1963	E				
<i>Biscutella vicentina</i> (SAMP.) GUINEA, 1964	E				
<i>Hyacinthoides vicentina</i> (HOFFMANN & LINK) ROTHM., 1944	E				
<i>Thymus camphoratus</i> HOFFMANN & LINK, 1809	E				
<i>Diplotaxis vicentina</i> (COUTINHO) ROTHM., 1940	E				
<i>Cistus palhinhæ</i> INGRAM, 1943	E				
<i>Astragalus massiliensis</i> (MILLER) LAM., 1783	E				
<i>Quercus canariensis</i> WILLD., 1809		R			
<i>Euphorbia monchiquensis</i> FRANCO & P. SILVA, 1968		E			
<i>Rhododendron ponticum</i> L. ssp. <i>baeticum</i> (BOISS. & REUTER) HAND-MAZZ., 1762		IE			
<i>Ilex aquifolium</i> L., 1753		R			
<i>Ophrys speculum</i> LINK in SCHRADER ssp. <i>lusitanica</i> O. & A. DANESCH			IE		
<i>Dittrichia viscosa</i> (L.) W. GREUTER ssp. <i>revoluta</i> (HOFFMANN & LINK) P. SILVA & TUTIN, 1973				E	
<i>Tuberaria major</i> (WILLK.) P. SILVA & ROZEIRA, 1964				E	
<i>Thymus lotocephalus</i> G. LÓPEZ & R. MORALES, 1984			E		
Thysanura (Microcoryphia)					
<i>Machilis sacra</i> MENDES, 1976	E				
<i>Machilis cf. lusitana</i> WYGODZINSKY, 1945		IE			
<i>Machilinus rosaliae</i> MENDES, 1977			E		
<i>Bachilis multisetosa</i> MENDES, 1977			E		
<i>Ditta bitschi</i> MENDES, 1976			E		
Thysanura (Zygentoma)					
<i>Ctenolepisma algarbica</i> MENDES, 1978	E				
<i>Ctenolepisma gaditana</i> MENDES, 1992					IE
<i>Coletinia mendesi</i> WYGODZINSKY, 1980					IE
Homoptera (Cicadoidea)					
<i>Tettigeta josei</i> BOULARD, 1982			E		
Homoptera (Coccoidea)					
<i>Kermes vermillio</i> PLANCHON			R		
Coleoptera (Cicindelidae)					
<i>Cicindela hybrida silvaticoides</i> HORN, 1937	E				
<i>Cephalota hispanica</i> (GORY, 1833)					IE (Tertiary relict)

Notes : (R) Rare species; (E) Endemic species; (IE) Iberian endemic species.

Phanerogams (ROCHA AFONSO, 1991); Thysanura (MENDES, 1985, 1992 and in litteris); Homoptera Cicadoidea (BOULARD, 1982; QUARTAU, 1995); Homoptera Coccoidea (CARMONA, 1985); Coleoptera Cicindelidae (HORN, 1937; SERRANO, 1988, 1995).

Furthermore, some interesting species of other arthropod groups (Table 3), collected by us from these areas, have been identified by specialists, some of them participants in the EU project where this study is integrated: "High Endemism Areas, Endemic Biota and the Conservation of Biodiversity in Western Europe" (1994-1998).

Table 2. Endemic or rare Collembola species from High Endemism Areas in Algarve.

	Sagres de Monchique	Serra	Barrocal	Ria Formosa	Castro Marim
<i>Microgastrura sensillata</i> JORDANA, 1981		IE		IE	
<i>Odontellina nivalis</i> (CASSAGNAU, 1959)			M		
<i>Deutomura atlantica</i> DEHARVENG, 1982		E			
<i>Deutomura coiffaiti</i> (DEHARVENG, 1979) (*)		E			
<i>Endonura baculifer</i> (DEHARVENG, 1979) (*)		E			
<i>Friesea acuminata</i> DENIS, 1925				A-M	
<i>Friesea pseudodecipiens</i> ARBEA & JORDANA, 1997		IE			
<i>Friesea ladeiroi</i> GAMA, 1959			A-M	A-M	A-M
<i>Friesea stachi</i> KSENNEMAN, 1936			M		
<i>Gamachorutes verrucosus</i> CASSAGNAU, 1978		IE	IE	IE	
<i>Fissuraphorura gisini</i> (SELGA, 1963)		A-M			
<i>Mesaphorura arbei</i> SIMON & LUCIAÑEZ, 1994		IE		IE	
<i>Mesaphorura florae</i> SIMON & LUCIAÑEZ, 1994	IE				IE
<i>Mesaphorura</i> sp. 1	IE	IE			
<i>Mesaphorura</i> sp. 2	E	E			
<i>Mesaphorura</i> sp. 3	E	E			
<i>Metaphorura denisi</i> SIMON, 1985			M		
<i>Onychlurus penetrans</i> GISIN, 1952			M		
<i>Cryptopygus debilis</i> (CASSAGNAU, 1959)	M	M	M	M	M
<i>Folsomides pocosensillatus</i> FJELLBERG, 1993	A-M				
<i>Folsomides xerophilus</i> FJELLBERG, 1993	A-M				
<i>Proisotoma coeca</i> GAMA, 1961		E			
<i>Proisotoma gisini</i> GAMA, 1964				E	
<i>Lepidocyrtus lusitanicus</i> GAMA, 1964		IE		IE	
<i>Lepidocyrtus tellecheae</i> ARBEA & JORDANA, 1990		IE			
<i>Pseudosinella</i> sp.					E
<i>Troglapedetes cavernicola</i> DELAMARE, 1944			E		
<i>Willowisia</i> sp.		E	E		
<i>Arrhopalites microphthalmus</i> CASSAGNAU & DELAMARE, 1953	M				
<i>Stenacidia hystrix</i> (BORNER, 1903)			M		

Notes : A-M Atlantic-Mediterranean species; E Endemic species; IE Iberian endemic species; M Mediterranean species; (*) Not found in this project sampling.

Materials and Methods

The results presented in this study were obtained using two different methodologies. The first one was a bibliographic research on published material from the Algarve area. The other one comprises the collection of samples in the field. For this purpose, five areas were chosen by their representativity in terms of landscape units from the Algarve region. At each site soil and litter samples were collected between 1994 and 1996; the biological material was then submitted to an identification by experts (Collembola were identified in our laboratory and other groups in different laboratories across Europe and U.S.A.). For more details concerning biotope characterization, sampling and soil analysis please refer to GAMA *et al.* (1997).

Table 3. Endemic or rare arthropods from High Endemism Areas in Algarve.

	Sagres	Serra de Monchique	Barrocal	Ria Formosa	Castro Marim
Isopoda					
<i>Trichoniscoides machadoi</i> VANDEL, 1946 (•)			E		
<i>Haplophthalmus sticulus</i> DOLLFUS, 1896 (•)			M		
<i>Buchnerillo littoralis</i> VERHOEFF, 1942 (**)				A-M	
<i>Armadilloniscus littoralis</i> BUDDÉ-LUND, 1885 (*)				A-M	
<i>Trichorhina anophthalma</i> ARCANGELI, 1935			IE		
<i>Stenoniscus pleonalis</i> AUBERT & DOLLFUS, 1890 (*)				A-M	
<i>Trogloarmadillidium machadoi</i> VANDEL, 1946 (•)				E	
<i>Paraschizidium olearum</i> VERHOEFF, 1917 (**)			(R) M		
<i>Ctenascia minima</i>				.	
Pseudoscorpiones					
<i>Chthonius</i> (E.) <i>gibbus</i> BEIER, 1952	M	M	M		
<i>Chthonius</i> (C.) <i>jonicus</i> BEIER, 1931 (*)	A-M				
<i>Chthonius</i> (C.) <i>halberti</i> KEW, 1916 (*)				Lusitanian	
<i>Microcreagrina hispanica</i> (ELLINGSEN, 1910)			M		
<i>Geogarypus minor</i> (L. KOCH, 1873)	M	M			
<i>Oiptum pallipes</i> (H. LUCAS, 1846)	M			M	
<i>Hysterocheilifer tuberculatus</i> (H. LUCAS, 1846)			M		
<i>Roncocreagrins cf. galeonsuda</i> (BEIER, 1955)		M			
Araneae					
<i>Theridion simile</i> C. L. KOCH, 1836			IP		
<i>Nigma puella</i> (E. SIMON, 1870)			IP		
Pauropoda					
<i>Allopauropus</i> (A.) <i>danicus</i> HANSEN, 1902*			C	C	
<i>Allopauropus</i> (D.) <i>aristatus</i> REMY, 1936*			H-Et		
<i>Allopauropus</i> (D.) <i>fagei</i> REMY, 1941*			(R)M		
<i>Allopauropus</i> (D.) <i>gracilis</i> (HANSEN, 1902)*			C		
<i>Allopauropus</i> (D.) <i>helophorus</i> REMY, 1936*			(R)Eu		
<i>Allopauropus</i> (D.) <i>productus</i> SILVESTRI, 1902*			H		
<i>Allopauropus</i> (D.) <i>therapneus</i> LECLERC, 1953*			M		
<i>Allopauropus</i> (D.) <i>zalanus</i> REMY, 1952*			M		
<i>Allopauropus</i> (D.) <i>assalinoae</i> SCHELLER, 1998*			?E		
<i>Pauropus numidus</i> REMY, 1947*			A-M		
Symphyla	"	"	"	"	"
Chilopoda	"	"	"	"	"
Diplopoda	"	"	"	"	"
Protura	"	"	"	"	"
Diptera					
<i>Podocampa ceballosi</i> (SILVESTRI, 1932)		M	M		
<i>Parajapyx</i> (P.) <i>isabellae</i> (GRASSI)			C		
Dermoptera					
		<i>Rhododendron</i> flowers			
Embioptera					
<i>Haploembia solteri</i> (RAMBUR, 1842)	M		M		M
Psocoptera					
<i>Graphopsocus cruciatus</i> (L., 1768)		<i>Rhododendron</i> flowers - Eu			
<i>Liposcells rugosa</i> BADONNEL, 1945*	A-M				
<i>Liposcells semicaeca</i> LIENHARD, 1990*			M		
<i>Liposcells brunnea</i> MOTSCHULSKY, 1852*					C
Hemiptera					
Thysanoptera					
<i>Odonothrips loiti</i> (HALDAY)*		<i>Rhododendron</i> flowers and in other sites			
Curculionidae					
Staphylinidae					
Cantharidae: Rhagonycha sp.		<i>Rhododendron</i> flowers			
Melyridae: Atallus sp.		<i>Rhododendron</i> flowers			
Nitidulidae: Meligethes sp.		<i>Rhododendron</i> flowers			
Alleculidae		<i>Rhododendron</i> flowers			
Chrysomelidae		<i>Rhododendron</i> flowers			
Diptera		<i>Rhododendron</i> flowers			
Hymenoptera Chalcidoidea		<i>Rhododendron</i> flowers			

Notes : (R) Rare species; (A-M) Atlantic-Mediterranean species; (IP) Iberian Peninsula; (E) Endemic species; (IE) Iberian endemic species; (M) Mediterranean species; (C) Cosmopolitan species; (Eu) European; (H) Holarctic; (H-Et) Holarctic-Ethiopian; (•) Not found in this project sampling; (*) Referred to Portugal for the first time; (**) Referred to the Iberian Peninsula for the first time.

Results

The arthropod species found in the Areas of High Endemism (HEA) of Algarve, where we have sampled, are as follows :

— *Península de Sagres*. It is a calcareous dolomitic region in the South-West extremity of Algarve, with relevant botanical value showing the existence of several endemic plants : *Iberis sampaiana*, *Biscutella vicentina*, *Hya-cinthoides vicentinus*, *Thymus camphoratus*, *Diploaxis vicentina*, *Cistus palhinhae* and *Astragalus massiliensis*. At the faunistic level, there are two endemic species of Thysanura (*Machilis sacra* and *Ctenolepisma algharbica*) and one endemic subspecies of Coleoptera (*Cicindela hybrida silvaticoides*).

From our sampling in this area 59 species of Collembola have been found, from which 9 are new to Portugal. Two species are Iberian endemics (*Mesaphorura florum* and *Mesaphorura* sp.1), two are presumed endemics (*Mesaphorura* sp.2 and *Mesaphorura* sp.3), and four species present a restricted distribution (*Cryptopygus debilis* and *Arrhopalites microphthalmus* are Mediterranean species and *Folsomides pocosensillatus* and *F. xerophilus*, described by FJELLBERG in 1993 from Canary Islands, must be considered Atlantic-Mediterranean species).

Furthermore, four species of Pseudoscorpiones, four species of Psocoptera and one species of Embioptera have been identified :

Pseudoscorpiones : *Chthonius* (*E.*) *gibbus*, *Geogarypus minor* and *Olpium pallipes* are Mediterranean species and *Chthonius* (*C.*) *jonicus*, cited for the first time from our country, was known from the Eastern Mediterranean, having been recently discovered in the Canary Islands (MAHNERT, *in litteris*).

Psocoptera : among the four species appearing in Sagres, *Liposcelis rugosa* is referred for the first time to the Portuguese fauna, being known from Morocco, the Canary Islands, Greece and Cyprus.

Embioptera : *Haploembia solieri* presents a Mediterranean distribution.

From the database of Didier DRUGMAND, one endemic species of Staphilinidae *Mesotyphlus* s. str. *maritimus* is represented in Sagres (Table 4).

— *Serra de Monchique*. It constitutes an area with marked characteristics, being the upper half of this mountain predominantly syenitic, including Foia (902 m high), whereas the lower zone is of schistous nature. In this geological massif we can find several interesting species of plants like the endemic *Euphorbia monchiquensis*, the relictual endemic *Rhododendron ponticum baeticum*, restricted to a few sites of Southern Iberian Peninsula, and *Quercus canariensis*, *Adenocarpus complicatus anisochilus* and *Ilex aquifolium* with a rare occurrence both in Portugal and Spain. At the faunistic level, one Iberian endemicity of Thysanura is known : *Machilis lusitana*.

Table 4. Endemic Staphylinidae species from High Endemism Areas in Algarve.

	Costa Vicentina	Monchique	Barrocal	Ria Formosa
<i>Astenus (A.) algarvensis</i> COIFFAIT, 1968			Loulé	
<i>Astenus (A.) algarvensis virgo</i> COIFFAIT, 1968			Alportel	
<i>Astenus (s. str.) jageli luteomarginatus</i> COIFFAIT, 1968			Alportel	
<i>Bythinus anguliceps</i> REITTER, 1885		Serra de Monchique		
<i>Cylindropsis (s. str.) littoralis</i> COIFFAIT, 1969	Ibufeira, Bordigueira	Alfêrce	Algoz, Alportel, Loulé, St.ª Catarina	Tavira
<i>Entomoculica (S.) vicinus</i> COIFFAIT, 1964			Loulé (St.ª Bárbara de Nexe)	
<i>Geomitopsis lusitanicus</i> COIFFAIT, 1965	Portimão			Faro
<i>Geostiba (L.) plicatella subopaculata</i> BERNHAUER, 1909				
<i>Hesperotyphlus algarvensis</i> COIFFAIT, 1964		Porto de Lagos		
<i>Hesperotyphlus lusitanicus</i> COIFFAIT, 1978	Algarve			
<i>Holotrochus lusitanicus</i> COIFFAIT, 1978		Barranco-do-Velho		
<i>Leptobium doderoi</i> GRIDELLI, 1926	Portimão			
<i>Lusitanopsis (s. str.) littoralis</i> COIFFAIT, 1969	Albufeira	Alfêrce	Alportel, Loulé	Tavira
<i>Lusitanopsis (s. str.) monchicus</i> COIFFAIT, 1969		Porto de Lagos		
<i>Lusitanopsis algarvensis</i> COIFFAIT, 1965				
<i>Mayetia (s. str.) algarvensis</i> COIFFAIT, 1961			Loulé	
<i>Medon lusitanicum</i> COIFFAIT, 1969			Silves	
<i>Mesotyphlus (A.) affinis</i> COIFFAIT, 1964			Algoz	
<i>Mesotyphlus (A.) albufetrensis</i> COIFFAIT, 1970			Loulé	
<i>Mesotyphlus (A.) bordigheirensis</i> COIFFAIT, 1970	Albufeira			
<i>Mesotyphlus (A.) campus</i> COIFFAIT, 1964	Bordigueira			
<i>Mesotyphlus (A.) furcatus</i> COIFFAIT, 1964	Boliqueime	Porto de Lagos		
<i>Mesotyphlus (A.) inversus</i> COIFFAIT, 1970			St.ª Catarina	
<i>Mesotyphlus (A.) montanus</i> COIFFAIT, 1964			Loulé (Querença)	
<i>Mesotyphlus (A.) paeonius</i> COIFFAIT, 1964			Loulé (Amendoeira)	
<i>Mesotyphlus (A.) rupestris</i> COIFFAIT, 1964			S. Brás de Alportel (Vilharinos)	
<i>Mesotyphlus (A.) siliquus</i> COIFFAIT, 1964			S. Brás de Alportel (S. Romão)	
<i>Mesotyphlus (A.) silvensis</i> COIFFAIT, 1964			Silves	
<i>Mesotyphlus (A.) simplex</i> COIFFAIT, 1964			S. Brás de Alportel (S. Romão)	
<i>Mesotyphlus (D.) brevis</i> COIFFAIT, 1970	Bordigueira			
<i>Mesotyphlus (D.) pervincus</i> COIFFAIT, 1964			Estoi	
<i>Mesotyphlus (D.) vicinus</i> COIFFAIT, 1964			St.ª Bárbara de Nexe	
<i>Mesotyphlus (s. str.) maritimus</i> COIFFAIT, 1964	Amoreira			
<i>Mesotyphlus (T.) rivularis</i> COIFFAIT, 1964		Porto de Lagos		
<i>Mimogonia europaea</i> COIFFAIT, 1978			St.ª Bárbara de Nexe	
<i>Nazeris algarvensis</i> COIFFAIT, 1971		Serra de Monchique		
<i>Paratyphlus (s. str.) algarvensis</i> COIFFAIT, 1964			Almancil, St.ª Bárbara de Nexe	
<i>Paratyphlus (s. str.) brazensis</i> COIFFAIT, 1964			S. Brás de Alportel	
<i>Paratyphlus (s. str.) carvoeirensis</i> COIFFAIT, 1970			Carvoeiro	
<i>Paratyphlus (s. str.) delicatulus</i> COIFFAIT, 1964			S. Brás de Alportel, S. Romão	
<i>Pselaphostomus franzi</i> BESUCHET, 1961		Monchique		
<i>Pseudobium gridellii ibericum</i> COIFFAIT, 1982			Alportel, Silves	Tavira
<i>Quedius (M.) crassus</i> var. <i>nigricans</i> GRIDELLI, 1924		Monchique		
<i>Xantholinus algarvensis</i> COIFFAIT, 1972		Caldas de Monchique, Porto de Lagos		

In this mountain, among the 46 species of Collembola identified, of which 9 are recorded for the first time in our country, we can denote *Deutonura coiffaiti*, *Endonura baculifer* (these two species were not present in our sampling), *Deutonura atlantica*, *Mesaphorura* sp. 2, *Mesaphorura* sp.3, *Proisotoma coeca* and *Willowsia* sp. which are endemic species, and *Microgastrura sensiliata*, *Friesea pseudodecipiens*, *Gamachorutes verrucosus*, *Mesaphorura arbei*, *Mesaphorura* sp.1, *Lepidocyrtus lusitanicus* and *Lepidocyrtus tellecheae* which are Iberian endemic species. Moreover, we have found in this area 3 species with a Mediterranean or Atlantic-Mediterranean distribution : *Fissuraphorura denisi*, *Onychiurus penetrans* and *Cryptopygus debilis*.

In respect to other groups of Arthropods, 3 Mediterranean species of Pseudoscorpiones (*Chthonius* (*E.*) *gibbus*, *Geogarypus minor* and *Roncocreagrais* cf. *galeonuda*), and one Mediterranean species of Diplura, *Podocampa ceballosi*, have been identified.

From the database of D. DRUGMAND, 12 endemic species of Staphylinidae were referred to Monchique (Table 4).

— *Barrocal Algarvio* : This region corresponds to a calcareous platform bordered at the Southern littoral by the sandy zone of the Barlavento and the Sotavento. All the Algarvian Barrocal, but chiefly the central area between Tavira and S. Bartolomeu de Messines, has a great ecological interest, with several examples of plants and insects with relevant biological value : the Iberian endemic *Ophrys speculum lusitanica*, the endemic *Thymus lotocephalus*, three endemic species of Thysanura, *Machilinus rosaliae*, *Bachilis multisetosa* and *Dilta bitschi*, the endemic species of Homoptera Cicadoidea, *Tettigeta josei*, and the rare species of Homoptera Coccoidea, *Kermes vermilio*.

From this area we have identified about 60 species of Collembola, from which 5 are new to our country. Three highly interesting species appeared here : the palaeoendemic *Troglopedetes cavernicola*, previously found exclusively in caves in the South of Portugal and collected here in soil, the neoendemic *Willowsia* sp. and another palaeoendemic Iberian species, *Gamachorutes verrucosus*, which also exists in the Serra de Monchique and Ria Formosa. Moreover, 6 species with a Mediterranean or Atlantic-Mediterranean distribution (*Odontellina nivalis*, *Friesea ladeiroi*, *F. stachi*, *Metaphorura denisi*, *Cryptopygus debilis* and *Stenacidia hystrix*) confirm the interest of this area.

Interesting species of other Arthropod groups have been collected in the Barrocal : 4 species of Isopoda, 3 species of Pseudoscorpiones, 11 species of Paupoda, one species of Diplura, one species of Psocoptera, and one species of Embioptera.

Isopoda : *Trichoniscoides machadoi* is endemic to Portugal, *Trichorhina anophthalma* is an Iberian endemic known from Serpa and Setúbal, Málaga and Algeiras, *Haplophthalmus siculus* is referred to the Iberian Peninsula, Sicily and Algeria and *Paraschizidium olearum* was known till now only from Minorca.

Pseudoscorpiones : *Chthonius (E.) gibbus*, *Microcreagrina hispanica* and *Hysterochelifer tuberculatus* present a Mediterranean distribution.

Paupoda : Among the 11 species identified from this area, 10 are new to Portugal, one of them, *Allopauropus (D.) assalinoae*, being a presumed endemic. Two species, *Allopauropus (D.) fagei* and *A. (D.) helophorus* are rare, presenting a restricted distribution, the first is a Mediterranean species and the second is an European species. Two other species, also belonging to this genus, present a Mediterranean distribution and *Pauropus numidus* an Atlantic-Mediterranean distribution (SCHELER, 1998).

Diplura : there is a Mediterranean species *Podocampa ceballosi* which also appeared in Monchique.

Psocoptera : *Liposcelis semicaeca* is a Mediterranean species which was collected for the first time in Portugal. It was known till now from the South of Spain (Andalusia) and Greece.

Embioptera : *Haploembia solieri* presents a Mediterranean distribution.

From the database of D. DRUGMAND 25 endemic species of Staphilinidae were identified in the Barrocal (Table 4).

— *Parque Natural da Ria Formosa*. It is a protected zone in the South-East of Algarve which is partially occupied by salt-marshes, sand dunes and pine forest. There are some endemic species of phanerogams such as *Tuberaria major* and *Dittrichia viscosa revoluta* and the entomofauna in general and particularly the Lepidoptera have a special interest.

About 58 Collembola species have been identified from this area of which 6 are cited from Portugal for the first time. We must emphasise the presence of one endemic species, *Proisotoma gisini*, and 4 Iberian endemic species, *Miccrogastrura sensiliata*, *Mesaphorura arbei* and *Lepidocyrtus lusitanicus* (which have also been found in Serra de Monchique) and the palaeoendemic *Gamachorutes verrucosus*, which also exists in Serra de Monchique and Barrocal. *Friesea acuminata* is characteristic of the littoral habitats and presents an Atlantic-Mediterranean distribution, *Friesea ladeiroi* is known only from Portugal and Madeira Island and *Cryptopygus debilis*, considered before an endemic to beech forest from the French Pyrenees, also exists in the Iberian Peninsula and in Crete. This species appeared in the five areas of high endemism of Algarve.

Some interesting species of Isopoda, Pseudoscorpiones and Paupoda have been identified from Ria Formosa :

Isopoda : one endemic species, *Troglarmadillidium machadoi*, cited exclusively from Faro, and 3 Atlantic-Mediterranean species, *Buchnerillo littoralis*, *Armadilloniscus littoralis* and *Stenoniscus pleonalis*.

Pseudoscorpiones : *Chthonius (C.) halberti*, presenting a Lusitanian distribution, is referred for the first time to our country and *Olpium pallipes* is a

Mediterranean species.

Pauropoda : *Allopauropus (A.) danicus*, new to Portugal, is very widely distributed (SHELLER, 1998).

From the database of D. DRUGMAND 4 endemic species of Staphilinidae have been recorded in this area (Table 4).

— *Reserva Natural do Sapal de Castro Marim*. This protected zone of salt-marshes is situated in the South-East extremity of Algarve, delimited on the South by Vila Real de Santo António and on the South-East by the Guadiana river. The entomofauna of this zone has a special interest, and an endemic Iberian species of Coleoptera (*Cephalota hispanica* - a Tertiary relict) and two Iberian endemic species of Thysanura (*Ctenolepisma guadianica* and *Coletinia mendesi*) are found exclusively here.

Among the 31 Collembola species identified from this area, 3 are recorded for the first time from our country. In spite of the small number of species found, there is a new species of *Pseudosinella*, probably endemic and an Iberian endemic species, *Mesaphorura florae*, which also exists in Sagres. *Friesea ladeiroi* and *Cryptopygus debilis*, already recorded from other areas of Algarve, are present in Castro Marim.

In respect to the other Arthropod groups, one species of Psocoptera, *Liposcelis brunnea*, which presents a large distribution, is referred to Portugal for the first time. *Haploembia solieri* is a Mediterranean species of Embioptera which appeared in Castro Marim, Barrocal and Sagres.

Discussion

All these areas are very important in terms of biodiversity conservation; the amount of new species referred for our fauna and the number of rare or endemic species mentioned above (Tables 1, 2, 3 and 4) helps in this goal.

It is difficult to grade the different areas, since each one of them supports a great variety of Collembola species and also interesting species from other Arthropod groups and plants. Even so, we would like to enhance the Serra de Monchique area, especially those biotopes dominated by *Rhododendron ponticum baeticum*, a relictual endemic shrub, occurring in Portugal only in this mountain and in the mountain of Caramulo, and also the biotope dominated by *Quercus canariensis*, which presents equally a very restricted occurrence both in Portugal and in Spain, with Serra de Monchique being its exclusive area in our country (ROCHA AFONSO, 1991). If we look at the presence of endemic Collembola species (Table 2) we could see that they are concentrated in this mountain, reinforcing this position. Moreover, in terms of Arthropod diversity in general, the Barrocal Algarvio represents equally a very important area with 3 highly interesting endemic species of Collembola, 2 endemic species of Isopoda, one presumed endemic of Pauropoda, 3 endemic species of Thysanura, one endemic species of Homoptera and 25 endemic species of Staphilinidae.

These five areas are constantly being threatened by several stress factors such as reafforestation with *Eucalyptus* in the Serra de Monchique, forest fires and by uncontrolled touristic development (a serious threat in coastal areas). In face of this situation, well established conservation plans are needed to avoid habitat degradation and local losses of biological diversity. Of course, preserving habitats without protecting those species living on those habitats is an impossible task. Protecting habitats is the most effective way for preserving biological diversity (PRIMACK, 1998).

Reinforcing the idea that endemic or rare biota represent, from a conservation perspective, the most valuable and vulnerable element of the fauna, implies that high endemism areas should therefore be considered a priority for conservation (DEHARVENG, 1996). It is our goal to make the data from this study available both to the scientific community and to the competent authorities in charge of nature conservation in Portugal; recommendations will be made to preserve or restore the biological richness of these areas, encouraging the adoption of protective measures and the creation of well defined research projects (GAMA *et al.*, 1997).

The authors acknowledge that for the preservation and the restoration of this biological richness, in addition to the creation of protective measures, it is absolutely necessary to recognize the essential role played by modern taxonomy in the identification and monitoring of the biological diversity components. There is a vital need for more taxonomic scientists to classify and protect the world's biological diversity before it is lost (PRIMACK, 1998).

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References

- BOULARD M., 1982. - Les cigales du Portugal, contribution à leur étude (Hom. Cicadidae). *Annales de la Société entomologique de France*, (N.S.) 18(2) : 181-198.
- CARMONA M.M., 1985. - Sobre a biologia de *Kermes vermilio* Planchon (Homoptera :

- Coccoidea). *Boletim da Sociedade portuguesa de Entomologia*, 2, supl. 1 : 433-444.
- DEHARVENG L., 1996. - Soil Collembola diversity, endemism, and reforestation : a case study in the Pyrenees (France). *Conservation Biology*, 10(1) : 74-84.
- FJELLBERG A., 1993. - Revision of European and North African *Folsomides* Stach with special emphasis on the Canarian fauna (Collembola : Isotomidae). *Entomologica scandinavica*, 23 : 453-473.
- GAMA M.M. DA, SOUSA J.P., FERREIRA C. & BARROCAS H., 1997. - Endemic and rare Collembola distribution in High Endemism Areas of South Portugal : A case study. *European Journal of Soil Biology*, 33 (3) : 129-140.
- HÄGVAR S., 1998. - The relevance of the Rio-Convention on biodiversity to conserving the biodiversity of soils. *Applied Soil Ecology*, 9 : 1-7.
- HORN W., 1937. - Über eine neue Rasse der *Cicindela hybrida* L. aus Portugal. *Natur-historisch Maandblad*, 26 : 94-95.
- MEFFE G.K. & CARROLL C.R., 1997. - Principles of Conservation Biology. 2nd edition. Sinauer Associates, Inc., Sunderland, Massachusetts. 729 pp.
- MENDES L., 1985. - Nota preliminar sobre os Tisanuros Microcoryphia e Zygentoma do Algarve (Portugal). *Boletim da Sociedade portuguesa de Entomologia*, supl 1 : 239-262.
- MENDES L., 1992. - New data on the Thysanuran (Microcoryphia and Zygentoma : Insecta) from the Guadiana River Valley in Algarve (Portugal). *Arquivos do Museu Bocage*, N.S. 2(13) : 275-286.
- PRIMACK R.B., 1998. - Essentials of Conservation Biology. 2nd edition. Sinauer Associates, Inc., Sunderland, Massachusetts. 660 pp.
- QUARTAU J.A., 1995. - Cigarras, esses insectos quase desconhecidos. *Correio da Natureza*, 19 : 33-38.
- ROCHA AFONSO M.L., 1991. - Plantas do Algarve. Serviço Nacional de Parques, Reservas e Conservação da Natureza, Lisboa. 395 pp.
- SHELLER U., 1998. - Pauropoda (Myriapoda) from Portugal. *Stobaeana*, 11 : 1-7.
- SERRANO A.R.M., 1988. - A synonymic note. *Boletim da Sociedade portuguesa de Entomologia*, 100 : p. 1
- SERRANO A.R.M., 1995. - Description and natural history of tiger beetles larvae (Coleoptera Cicindelidae) from Castro Marim - Vila Real de Santo António region (Algarve, Portugal). *Arquivos do Museu Bocage*, N. S. 2(33) : 555-606.